Fast Turnaround Analyses of Critical Infrastructure & Tool Development to Support Analytic Efforts

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The National Infrastructure Simulation and Analysis Center (NISAC)

The National Infrastructure Simulation and Analysis Center (NISAC), a program under the Department of Homeland Security's Information Analysis and Infrastructure Protection (IAIP) Directorate, provides advanced modeling and simulation capabilities for the analysis of critical infrastructures, their interdependencies, vulnerabilities, and complexities. These capabilities help improve the robustness of our nation's critical infrastructures by aiding decision makers in the areas of policy analysis, investment and mitigation planning, education and training, and near real-time assistance to crisis response organizations.

NISAC is a partnership between Sandia National Laboratories (SNL) and Los Alamos National Laboratory (LANL), integrating the two laboratories' expertise in infrastructure disruption/vulnerability modeling and simulation.

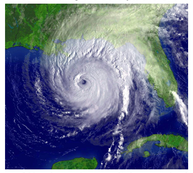
Fast Turnaround Analyses

History and Method

In its early months of DHS sponsorship, NISAC was faced with a wide variety of questions that went beyond the boundaries of any one project or expert set. The time requirements involved in these efforts have ranged from 6 hours to 90 days.

The Fast Turnaround Analysis (FTA) team was formulated to serve as a central resource point for DHS in providing relevant and practical information in response to issues of national importance under limited time constraints.

Models and tools developed by NISAC are used as needed within particular fast turnaround efforts to provide insight and analysis pertaining to the questions as posed. The FTA team also integrates expertise from throughout NISAC, including the core partners, their collaborators and system experts.



Satellite image of Hurricane Ivan as it Approached the U.S. Gulf Coast (source: NOAA).

Prediction of Economic Damage Contours for Hurricane Ivan (source: NISAC analysis).

Questions Addressed in Fast Turnaround Analyses

The information and analyses supplied by the team cover wide-ranging subjects; however, some common themes include:

- Who will be affected (e.g., population, economic sectors), and how (e.g., duration, scale)?
- Economic impacts
  - by economic or industrial sector
  - by state or region
  - insured and uninsured
  - abandoned and deferred purchases
- What are the unexpected consequences, primarily with respect to infrastructure interdependencies?

Analyses include simulations infrastructure sectors, infrastructure dependencies and interdependencies. Simulation tools used include

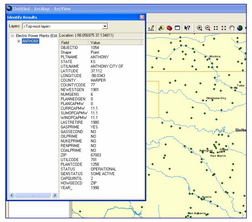
- Economic modeling
- Dynamic simulations of infrastructures and their interdependencies.

Two Problems, A Solution, and a Method

The Problems of Data Association and Translation

Providing an adequate and useable analysis of an asset is a function of the analyst's ability to process information from multiple sources. It is also a function of the analyst's knowledge of interdependencies among asset types. As a result, the effort can be very time consuming, and is subject to errors, particularly errors of omission.

Often, geospatial data is viewed as valuable, especially at first glance. This geospatial data often includes other information pertinent to the development of a knowledge base on that asset – but the information is often hidden to the non-expert user behind abbreviations (both to field names and data fields) that obscures the meaning and, again, creates the potential for error in analysis.



One Solution – The Fast Analysis Infrastructure Tool

NISAC has been developing the Fast Analysis Infrastructure Tool (FAIT), with these problems in mind.

FAIT is an expert system, designed with an understanding of the nature of interdependencies among infrastructure assets. It is designed to synergistically assemble this expert knowledge and the data resources available to NISAC through DHS, to automatically identify interdependencies and co-locations of infrastructure; to improve confidence in the data available; and to indicate where additional data resources need to be developed.

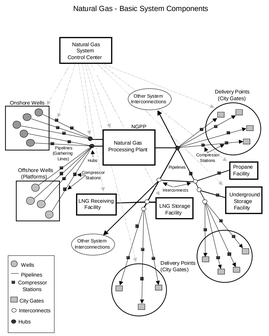
Expert elicitation gives us rules – and identifies where data are needed

At the core of the FAIT capability is an understanding, at the fundamental level, of the relationships between one infrastructure asset and assets in all infrastructures.

This process begins by identifying, with the aid of systems experts for each sector, the set of assets within that sector for which spatial data should exist. Within that sector, a connectivity model (such as the one shown in the figure at left) is developed, defining the existence of relationships between infrastructure assets. Cases, based on specific metadata that should be available about the asset, are then developed to attempt to define all the possible means of connectivity. In a similar fashion, co-location of assets can be analyzed based solely on the available spatial data valuation.

These sector-based connectivity models are then enhanced to include an understanding of the importance of the connection, and the scale of the time delay involved in a disruption. The relationships are encoded and called upon for analysis of any specific asset.

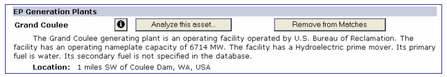
As a whole, this process provides a useful side benefit, in that it takes place in the absence of the complete knowledge of the availability of spatial and metadata. This helps to point out gaps in our knowledge base. Moreover, implementation of the rule set established enables the user to develop an understanding of the validity of the data already accessible.



What FAIT Does

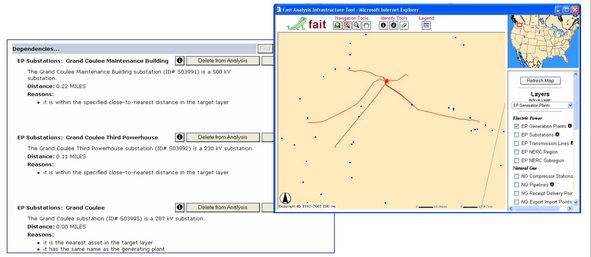
Provides a natural language explanation of what is known about an asset

FAIT provides a natural language translation of geospatial data sets that enables a user to quickly understand and comprehend vital data pertaining to an asset.



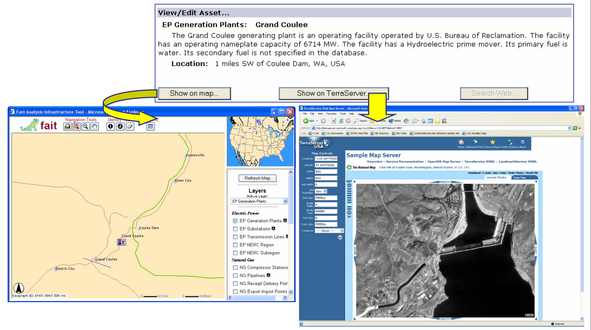
Identifies Asset Dependencies and Co-Locations

FAIT's rule engine identifies asset dependencies and co-locations based on the rules as established and on the data available. Some rules (such as the co-location distance for certain assets) can be modified by the end user to narrow or expand the result set. These dependencies can be viewed in textual and spatial formats. Users can also modify the matches found by the rule engine to eliminate erroneous matches



Provides Users Means of Verifying & Validating Spatial Data

FAIT provides links to external spatial data sources, so that end users can validate the location of spatial data in current data sets.



Paths Forward for FAIT

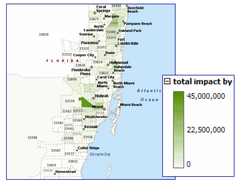
A variety of exciting developments are planned for the remainder of FY 2005 to greatly expand the capabilities of FAIT, and to assist the infrastructure analyst in providing timely and useful analytic products to customers at DHS.

Expanding the Rule Engine

The FAIT rule engine, currently comprised of rules for assets in the electric power and natural gas sectors, will be expanded to include assets in petroleum, oil and lubricants (POL) and wire line telecommunications. Other infrastructures will follow in FY 2006.

Adding Economic Accounting Capabilities

The vast majority of analytic products delivered by the FTA team incorporate some degree of economic accounting for disruption to infrastructure and the dependent economy, both locally and beyond. NISAC economists are developing an 'economic kernel' that FAIT will employ to rapidly provide visual understanding of economic circumstances in a region, and to calculate direct and indirect economic effects of disruptions, that can be incorporated into FAIT analytic products.



User Generated Knowledge Elements

Often, the analyst is familiar with particular pieces of information pertinent to an asset to be analyzed. Whether the knowledge element is asset specific, asset-type specific, or infrastructure specific, FAIT will incorporate the capability to generate and incorporate previously generated knowledge elements into an asset analysis.

Summary Report for Archival Storage and Distribution

Asset reports for FAIT need to be available in a distributable, archival format. FAIT will connect with other NISAC knowledge management efforts to provide storage for completed analyses. FAIT analyses will also be output to one of a number of standardized document formats. Analyses using FAIT will be compact enough in size to enable easy distribution of analysis results to customers and partners.

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